

# Established ‘Lisbon’ Lemon Trials in Arizona – 2002-03<sup>1</sup>

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## Abstract

*Four ‘Lisbon’ lemon selections, ‘Frost Nucellar’, ‘Corona Foothills’, ‘Limoneira 8A’ and ‘Prior’ were selected for evaluation on Citrus volkameriana rootstock. 1994-2002 results indicate that the ‘Limoneira 8A Lisbon’ and ‘Corona Foothills Lisbon’ are superior in yield and fruit size. Results for 2002-03 indicate that these cultivars as well as ‘Frost Nucellar’ have superior yield.*

## Introduction

There is no disputing the importance of citrus scion cultivars to desert citrus production. A successful citrus cultivar must be adaptable to the harsh climate, (where average high temperatures are often greater than 40°C), must be vigorous and must produce high yields of good quality fruit of marketable size.

Lemons are the most important and profitable citrus cultivar grown in Arizona today. Today, lemons comprise 45% of all harvested citrus acreage in the state. When the lemon industry was established in the 1950’s the principal variety was the ‘Desert Lisbon’. No records exist as to the characteristics of this variety. Within a few years however, ‘Desert Lisbon’ was eclipsed in popularity by ‘Frost Nucellar Lisbon’ the only nucellar clonal selection of the ‘Lisbon’ variety. Other popular clonal selections of ‘Lisbon’ that have been planted in Arizona include ‘Monroe’, ‘Limoneira 8A’, ‘Corona Foothills (also known as Foothills)’, ‘Prior’, and ‘Rosenberger’. All of these represent selections of outstanding trees that were then propagated. All are identified by their originator or place of origin, and are characterized by high vigor, high productivity, precocity (trees bear at an early age), earliness (a high percentage of the fruit can be harvested before 15 November), short thorns and good fruit quality. However, there is a certain amount of variability among ‘Lisbon’ clonal selections.

As the Arizona lemon industry has found itself a marketing niche for the late summer and early fall harvest, high productivity, good fruit quality and earliness have become increasingly important. Selections that have not met these standards have been superseded by selections that have these characteristics. Consequently, by 1992, the most popular clonal lemon selection grown in Arizona was the ‘Limoneira 8A Lisbon’. This selection originated in Santa Paula, CA, exhibits high productivity, precocity, earliness, and has adequate fruit quality. Other ‘Lisbon’ selections still grown in Arizona include ‘Prior’ and ‘Frost Nucellar’. ‘Corona Foothills’ is a more recent introduction that originates in Corona, CA. Not much is known about this selection, other than it has a reputation for high productivity. Therefore, we planted the first ‘Lisbon’ lemon selection trial in 1993 including ‘Limoneira 8A Lisbon’, ‘Prior Lisbon’, ‘Frost Nucellar Lisbon’, and ‘Corona Foothills Lisbon’ lemon on *C. volkameriana* as the rootstock. . Previous results from this trial have been reported in Wright and Peña (2002), Wright and Peña (2001), Wright and Peña (2000), Wright *et al.* (1999), Wright (1998), Wright (1997), Wright (1996) and Wright (1995).

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## Materials and Methods

This trial was established in March 1993 in Block 26 of the Yuma Mesa Agricultural Center, near Yuma, Arizona. The land was laser leveled and fumigated prior to planting. Trees were planted on a 9.1-m x 9.1-m (30 ft x 30 ft) spacing. Twelve replicates of each of the 4 selections were planted, for a total of 48 trees. Experimental design is randomized complete block.

Irrigation is border flood, and normal cultural practices are used. Growth data, expressed as trunk diameter, was taken annually through 1997. Measurements were taken about 4 inches above the bud union. These locations are permanently marked with paint. Trunk diameters were taken annually in March, so as to quantify any differential growth rates that might have occurred. Leaves are collected annually in August for mineral analysis; however there have been no significant differences in leaf nutrient content. Yield data is collected during the fall and winter. Trees are ring or strip-picked as noted below. Harvested fruit for each tree is collected in wooden or plastic boxes and weighed. Prior to 1999-2000, approximately 30 lbs of fruit was sub-sampled from the harvested yield of each tree for packout determination, and these were sized by hand using rings and graded by visual observation. Since 1999-2000, the entire harvest from each tree has been passed through an automated electronic eye sorter (Autoline, Inc., Reedley, CA), which provides weight, color, exterior quality and size data for each fruit. Fruit packout data is reported on a percentage basis. Fruit quality data is collected at each harvest time. These data include °brix, peel thickness, percentage juice, pH, and total soluble solids to total acid ratio. There was no effect of lemon selection on fruit quality (data not shown).

All data was analyzed using SPSS 7.0 for Windows (SPSS Inc., Chicago, Illinois).

## Results

For ease of viewing, annual yields for the four scions tested can be seen graphically in Figure 1.

There were no yield differences among the scions tested during the 1994-95-harvest season (Table 1). Yields across the entire experiment in 1995-96 and 1996-97 were light, but 'Limoneira 8A Lisbon' trees had 2 to 2.5 times the yield of the other scion cultivars. For 1997-98, the yield of 'Limoneira 8A' was 2 to 3.7 times higher than the other cultivars tested. For 1998, 'Limoneira 8A Lisbon' was again superior, but to a lesser degree than in previous years. Yield of 'Limoneira 8A' was from 1.2 to 1.7 times greater than the other selections, and 'Corona Foothills Lisbon' was the second best selection. From 1994-95 through 1998-99, there was no difference in fruit packout among the selections tested. For the 1999-2000 harvest, there was no significant difference between the scions in the total yield, or in the percent of fruit harvested before 15 November. 1999-2000 was the second year that 'Corona Foothills' performed as well as 'Limoneira 8A', and the first year that 'Frost Nucellar' and 'Prior' performed as well as 'Limoneira 8A'.

For the 2000-01 harvest year, total yields were 2 to 2.5 times those of 1999-2000 (Table 2). 'Limoneira 8A' trees reclaimed the top yielding spot for the first harvest although not significantly different than 'Corona Foothills' or 'Prior', while 'Frost Nucellar' lagged. For the second harvest, there was no significant difference between the scions tested, nor were there any significant differences in total yield, or fruit earliness.

For 2001-02, yields increased from 8 to 34% over the previous year. There was no effect of 'Lisbon' lemon selection on first harvest, second harvest or overall yield, or percent early fruit (Table 3). 'Corona Foothills' trees had the most fruit, followed by 'Limoneira 8A', 'Prior' and 'Frost Nucellar'.

For 2002-03, 'Frost Nucellar Lisbon' had the greatest total yield, while 'Prior Lisbon' had significantly less (Table 4). 'Corona Foothills' and 'Limoneira 8A' had intermediate yields, both not significantly different than either of the other two selections tested. These yield differences were not due to the first harvest yield, but to the second harvest yield. There were no differences in packout between the selections for the first harvest (Fig. 2); however differences did exist for the second harvest packout (Fig. 3). 'Corona Foothills' and 'Prior' had more size 95 fruit

than did 'Frost Nucellar' in the second harvest, while 'Limoneira 8A' was intermediate. Conversely, 'Frost Nucellar' had more size 140, 165 and 200 fruit than did 'Corona Foothills' and 'Prior'. Again, 'Limoneira 8A' was intermediate. Although 'Prior' had larger fruit in the second harvest, the second harvest yield and overall yield was lowest of the four selections tested. On the other hand, 'Frost Nucellar' had the greatest yield, but smaller fruit size. 'Corona Foothills' and 'Limoneira 8A' had yield not significantly different than 'Frost Nucellar', but with greater fruit size in the second harvest.

## **Discussion and Conclusions**

For the scions, both 'Limoneira 8A' and 'Corona Foothills' still appear to be superior to the other selections tested. Yields for 'Limoneira 8A' were the greatest for the first seven years of this nine-year study. Additionally, fruit size was generally larger for this selection, particularly in the first harvest, compared to the other selections tested. However, for 2001-02 and 2002-03, 'Limoneira 8A' has not had the greatest yield, and yet those yields are not significantly less than the other selections. Cumulative yield for the 'Limoneira 8A' since planting is 2095 lbs per tree; the greatest 9-year cumulative yield for all the selections in this trial. Whether 'Limoneira 8A' will remain superior is still not known. Nonetheless, this scion is still the industry standard, and is recommended for planting.

Yield of 'Corona Foothills' has equaled or surpassed 'Limoneira 8A' for the third year in a row, and fruit size for this selection seems to be superior to all others. However for five of the first six years of this trial, this selection was inferior to 'Limoneira 8A'. This early inferiority is reflected in the cumulative yield for 'Corona Foothills' of 1991 lbs per tree; about 5% less than 'Limoneira 8A'. Based on its recent performance, this scion is also recommended for planting.

'Frost Nucellar Lisbon' performed well in 2002-03; the first year in which it has done so. Before this season, this selection has typically had lower, although not always significantly lower, yield than the other selections tested. Cumulative yield for 'Frost Nucellar' since the inception of this experiment is only 1795 lbs. per tree, about 17% less than 'Limoneira 8A'. It remains to be seen if the superior yield this season is a one-time phenomena or an indication of permanent improvement.

After two seasons of superior performance, yield of 'Prior Lisbon' was significantly lower in 2002-03. This marks a return to its lower performance from 1994 through 2000. Cumulative yield for this selection since the start of the experiment is 1725 lbs. per tree, about 21% less than 'Limoneira 8A'. While fruit size was good for this selection, the lower yield cannot be discounted.

## **Literature Cited**

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Table 1. 1994-2000 yields of four ‘Lisbon’ lemon cultivars budded to *C. volkameriana* rootstock.

Scion <sup>z</sup>	Yield per tree (lb.).					
	1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000
‘Corona Foothills Lisbon’	0.13 a <sup>y</sup>	4.98 b	11.33 b	18.43 b	281.13 b	187.39 a
‘Frost Nucellar Lisbon’	0.07 a	3.97 b	14.48 b	26.61 b	204.96 c	150.79 a
‘Limoneira 8A Lisbon’	0.13 a	10.56 a	27.71 a	69.07 a	343.34 a	191.36 a
‘Prior Lisbon’	0.00 a	3.90 b	15.19 b	34.92 b	202.10 c	134.48 a

<sup>z</sup> Values are the means of 12 trees.<sup>y</sup> Means separation in columns by Duncan’s Multiple Range Test, 5% level.Table 2. 2000-2001 yields of four ‘Lisbon’ lemon cultivars budded to *C. volkameriana* rootstock.

Scion <sup>z</sup>	Yield per tree (lb.).			Percent Early Fruit <sup>x</sup>
	9/28/00	12/4/00	Total Yield	
‘Corona Foothills Lisbon’	140.21 ab	228.18 a	368.39 a	38.0 a
‘Frost Nucellar Lisbon’	113.76 b	174.38 a	288.14 a	43.8 a
‘Limoneira 8A Lisbon’	174.60 a	197.75 a	372.36 a	47.2 a
‘Prior Lisbon’	153.22 ab	208.11 a	361.33 a	44.0 a

<sup>z</sup> Values are the means of 12 trees.<sup>y</sup> Means separation in columns by Duncan’s Multiple Range Test, 5% level.<sup>x</sup> Percentage of fruit harvested prior to 15 November.Table 3. 2001-2002 yields of four ‘Lisbon’ lemon cultivars budded to *C. volkameriana* rootstock.

Scion <sup>z</sup>	Yield per tree (lb.).			Percent Early Fruit <sup>x</sup>
	9/27/01	11/28/01	Total Yield	
‘Corona Foothills Lisbon’	69.02 a	365.34 a	434.36 a	14.8 a
‘Frost Nucellar Lisbon’	43.94 a	340.74 a	384.68 a	12.1 a
‘Limoneira 8A Lisbon’	62.93 a	345.57 a	408.50 a	16.0 a
‘Prior Lisbon’	45.94 a	345.21 a	391.16 a	11.7 a

<sup>z</sup> Values are the means of 12 trees.<sup>y</sup> Means separation in columns by Duncan’s Multiple Range Test, 5% level.<sup>x</sup> Percentage of fruit harvested prior to 15 November.Table 4. 2002-03 yields of four ‘Lisbon’ lemon cultivars budded to *C. volkameriana* rootstock.

Scion <sup>z</sup>	Yield per tree (lb.).			Percent Early Fruit <sup>x</sup>
	9/26/02	12/16/02	Total Yield	
‘Corona Foothills Lisbon’	50.56 a	634.24 ab	684.81 ab	7.3 a
‘Frost Nucellar Lisbon’	65.73 a	655.17 a	720.91 a	10.0 a
‘Limoneira 8A Lisbon’	62.79 a	613.43 ab	671.73 ab	9.3 a
‘Prior Lisbon’	61.24 a	531.02 b	582.06 b	10.5 a

<sup>z</sup> Values are the means of 12 trees.<sup>y</sup> Means separation in columns by Duncan’s Multiple Range Test, 5% level.<sup>x</sup> Percentage of fruit harvested prior to 15 November.

Fig. 1. 1994 -2003 Yields of four 'Lisbon' Lemon Selections  
on *C. volkameriana* rootstock.

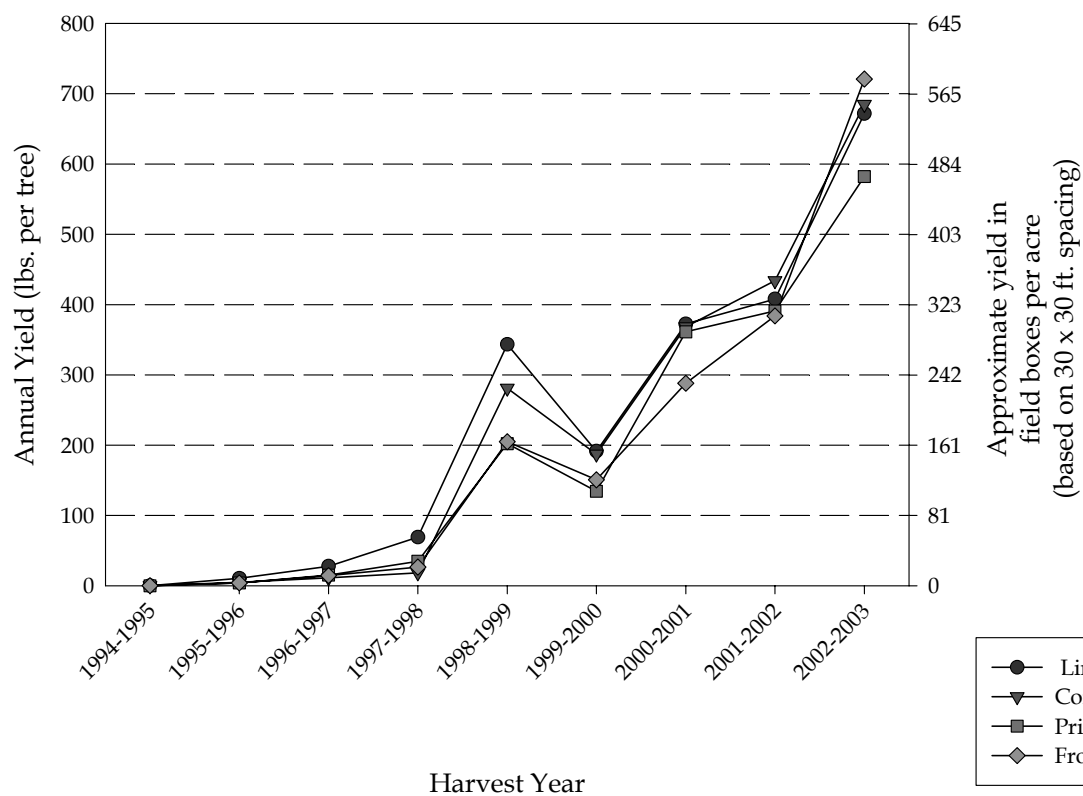
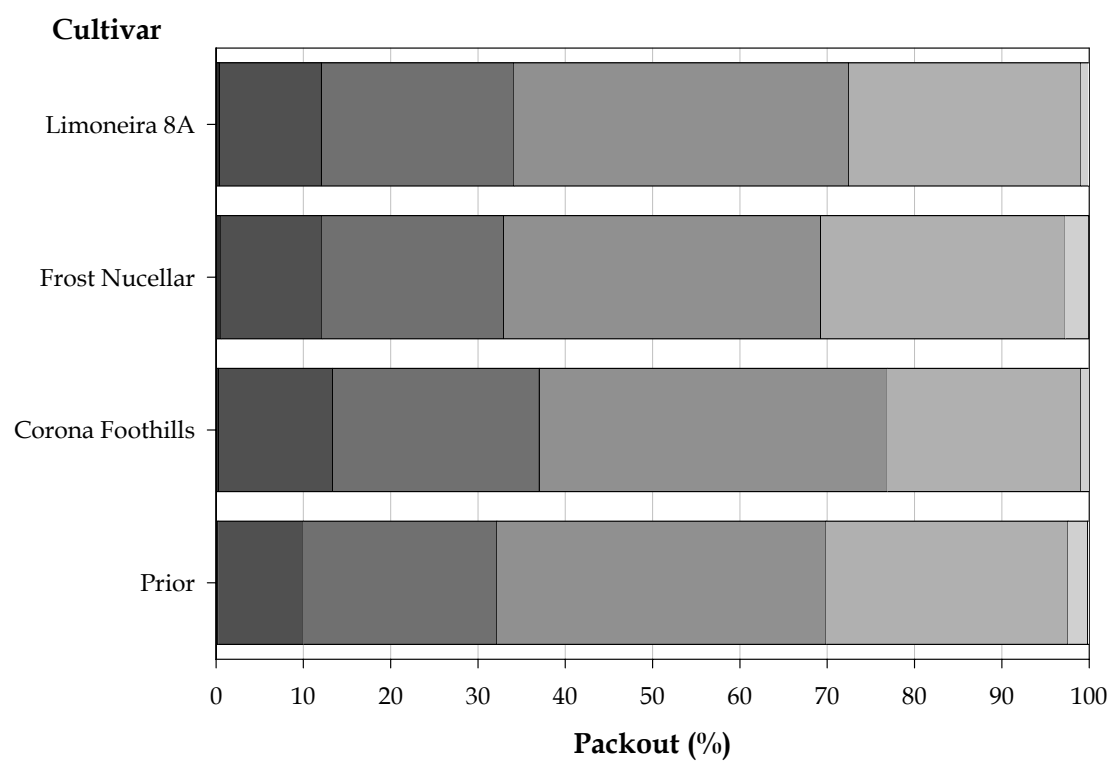
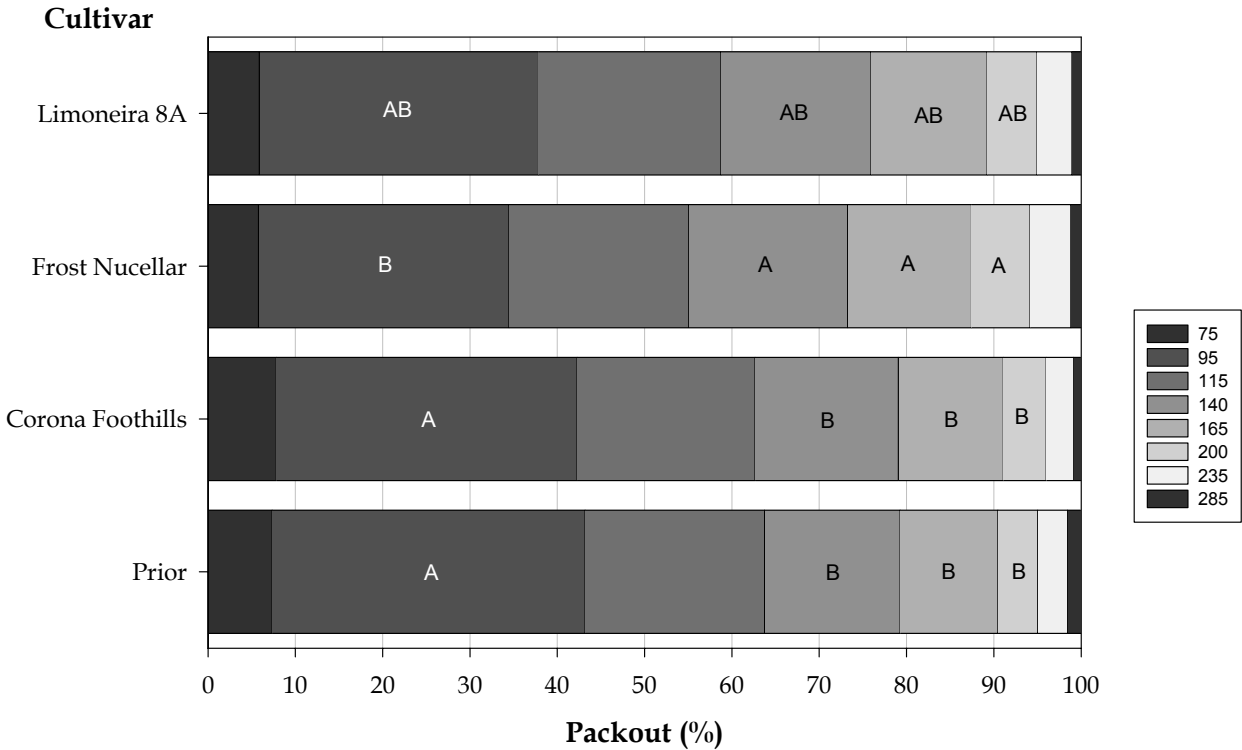


Fig. 2. 2002-03 Established 'Lisbon' Lemon Selection Packout - 9/26/02 Harvest



There was no significant effect of cultivar selection on fruit packout.

Fig. 3. 2002-03 Established 'Lisbon' Lemon Selection Packout - 12/16/02 Harvest



Bar segments of the same shade with the same letters represent packout percentages that are statistically the same.